

REMARKS/ARGUMENTS

Application Amendment/Claim Status

By the amendment presented, the specification is rewritten in the cross-reference to related applications paragraph to more accurately characterize the relationship of this application to its parent application, to correct some previously introduced application citation errors, and to update the status of its grandparent case. The claims in this application are not being amended herein. The claims therefore remain as set forth in the Listing of Claims presented with the December 19, 2007 Amendment in this application. These claims include Claims 1, 2, 4-15, 17-26, 28-39, 41-46 and 49-57.

Invention Synopsis

By way of review, the present invention, as now claimed, in one embodiment is directed to an integrated process for the production of a dialkyl carbonate and a diol from an alkylene oxide, carbon dioxide (CO₂) and a monohydric alcohol. In a first process step of this embodiment, the alkylene oxide and CO₂ are reacted under certain specified conditions in the presence of a halogen-free carbonation catalyst selected from carbonates and bicarbonates of quaternary ammonium bases to produce a crude product stream containing a cyclic carbonate and the catalyst. In a second process step, the cyclic carbonate, catalyst from the first step, and monohydric alcohol are then reacted to provide another crude product stream comprising the desired dialkyl carbonate and diol. This resulting crude product stream can have a halogen concentration only of about 5 ppm or less.

In other process embodiments, a transesterification catalyst is used in the second step along with the first step carbonation catalyst. In still further embodiments, the process includes a preliminary step wherein the alkylene oxide and CO₂ reactants are themselves produced by reaction of an alkylene material with an oxygen-containing gas. In the process embodiment of original Claim 58 (now Claim 49), the process is carried out using a chlorine-free carbonation catalyst which is [1,1'-(1-butylbenzimidazol-2-yl)pentane]copper(II) di(trifluoromethanesulfonate).

Formal Matters

Claim 49 has been rejected under 35 U.S.C. §112, Second Paragraph, as allegedly being indefinite in the characterization of the crude product stream as having “a chloride concentration of about 5 ppm or less.” The Examiner contends that such an element is indefinite because it does not appear that any of the reactants, catalysts or final products of the process have any chloride in them. Such a rejection is respectfully traversed.

This rejection of Claim 49 is similar to a rejection of Claims 1-46 which was applied during the pre-RCE prosecution of this application. That rejection was traversed and overcome via the observations and arguments presented in applicants’ July 19, 2006 Amendment. Similar observations and arguments can be made about this Section 112 rejection of Claim 49.

As noted in the specification and in the prior art documents cited in connection with the art rejection, reaction of alkylene oxide with CO₂ to produce cyclic carbonates which can then be further reacted with diols has conventionally involved the use of a chloride-containing carbonation and/or esterification catalyst. Such a procedure also can typically employ injection of HCl in a halogen mitigation step. Thus, even though the essentially used reactants and catalyst of the Claim 49 process embodiment are not characterized as any materials which contain chloride, the use of chloride-containing catalyst or of an HCl halogen mitigation step would not be excluded from the Claim 49 process without the “chloride concentration of 5 ppm or less” element recited in Claim 49.

Rather than render Claim 49 indefinite, it is submitted that the use of the objected-to phrase, in fact, renders Claim 49 more definite and precise. It cannot properly be argued that the skilled artisan would not know what materials or procedures to avoid in order to satisfy the “5 ppm or less chloride” element in Claim 49. Accordingly, it is further submitted that inclusion of the phrase “a chloride concentration of 5 ppm or less” in Claim 49 puts this claim in complete compliance with the definiteness requirements of 35 U.S.C. §112, Second Paragraph.

Art Rejection

Claims 1, 2, 4-15, 17-26, 28-39, 41-46 and 50-57 have been rejected under 35 USC §103(a) as allegedly being unpatentably obvious over U.S. Patent No. 5,489,703 to Pacheco et al (hereinafter “Pacheco”), in view of the combination of U.S. Patent No. 3,535,341 to

Emmons et al. (hereinafter “Emmons”); U.S. Patent No. 2,873,282 to McClellan (hereinafter “McClellan”); Masahiro et al (JP 63-238043, hereinafter “Masahiro”); Haruyuki et al (JP 03-109358, hereinafter “Haruyuki”) and Tojo et al (U.S. Patent 5,847,189, hereinafter “Tojo”). The Examiner contends that it would have been obvious to utilize the quaternary ammonium carbonation and transesterification catalysts of the secondary references in the Pacheco epoxide-to-alkylene carbonate-to-alkyl carbonate process, to thereby realize the various process embodiments of applicants’ rejected claims. Such a rejection is respectfully traversed.

As noted in applicants’ previous December 19, 2007 response, Pacheco discloses a process for reacting alkylene carbonates with alkanols in the presence of a transesterification catalyst which can include alkyl or aryl ammonium salts such as the halide, carbonate, or bicarbonate salts among many others. Pacheco notes that the ethylene carbonate reactant itself can be produced by reacting epoxides with carbon dioxide in the presence of catalysts such as carbonates or, most preferably, halides of organic nitrogen bases such as tertiary amines and quaternary ammonium bases along with many other catalyst types. There is no disclosure in Pacheco of using a crude alkylene carbonate product stream, which still contains the carbonation catalyst, as the reactant stream for transesterification of the alkylene carbonate with alkanols to produce dialkyl carbonates. The only exemplified dialkyl carbonate preparation in Pacheco involves combining a stream containing only ethylene or propylene carbonate and methanol with a potassium carbonate transesterification catalyst in glass tubes.

McClellan discloses reaction of alkylene oxides with carbon dioxide in the presence of a catalyst, which can be hydroxides, carbonates or bicarbonates of quaternary ammonium bases, to produce alkylene carbonates. There is no disclosure in McClellan of the further processing of any alkylene carbonate or alkylene carbonate-containing stream produced in accordance with the McClellan procedure.

Emmons discloses reaction of alkylene oxide with carbon dioxide to make a cyclic carbonate using hydrazine or hydrazine hydrohalide as a catalyst. In the Background section and in some comparative examples, Emmons teaches that quaternary ammonium bases such as tetraethylammonium carbonate, among many other possible types of catalysts, can be used to promote reaction of alkylene oxide with carbon dioxide. Emmons discloses nothing about

what is or can be done with the crude reaction product of the alkylene oxide/CO₂ reaction other than to analyze it or to distill cyclic carbonate reaction product from it.

Masahiro and Haruyuki both disclose preparation of dialkyl carbonates by reacting a cyclic carbonate with an alcohol under certain specified conditions in the presence of a solid strong basic anion exchange resin. The anion exchange resin can contain both quaternary ammonium groups and carbonate or bicarbonate groups as well as halide anions. There is no disclosure in either Masahiro or Haruyuki concerning how the cyclic carbonate used in the disclosed process has been prepared. There is certainly no disclosure in either Masahiro or Haruyuki of feeding to the disclosed processes any cyclic carbonate-containing stream which still contains the carbonation catalyst used to prepare the cyclic carbonate.

The Tojo patent discloses a method for continuously producing a dialkyl carbonate and a diol in a multi-stage distillation column by reacting a cyclic carbonate and a monohydric alcohol in the presence of a transesterification catalyst. The catalyst used in the Tojo procedure can include the same type of solid anion exchange resin mentioned in the Masahiro and Haruyuki references. Example 1 of Tojo uses a Dowex anion exchange resin which contains exchangeable quaternary ammonium, chloride and carbonate groups. As with Masahiro and Haruyuki, there is no teaching in Tojo concerning the source or the nature of the feed stream containing the cyclic carbonate used in the disclosed processes or any teaching or suggestion of using as a feedstream a cyclic carbonate material which still contains the carbonation catalyst used for its preparation.

As with the previously applied rejection discussed in applicants' December 19, 2007 Amendment, applicants respectfully submit that the combined teachings of the Pacheco primary reference and the four secondary references do not lead to an obvious realization of applicants' claimed process. In the first place, there is nothing in any of the applied references which would suggest that the alkylene (cyclic) carbonate-containing crude product stream from the first step of the applicants' claimed process must be used in the second transesterification step without separating either the alkylene carbonate or the carbonation catalyst therefrom. The primary Pacheco primary reference and the Masahiro, Haruyuki and Tojo secondary references all do disclose a reaction step involving transesterification of alkylene carbonate with alkanol. But in the Pacheco process and in the processes of these three newly applied secondary references, there is simply no disclosure or suggestion of using the same carbonation catalyst and the actual crude product stream from the carbonation step

for the disclosed transesterification reaction. Instead, the Pacheco reference appears to separate out the alkylene carbonate product and combine it as a purified reactant with methanol in order to carry out the further reaction which produces the desired alkyl carbonate via the transesterification step. The Masahiro, Haruyuki and Tojo secondary references are simply silent as to the nature of the cyclic carbonate source used in the disclosed transesterification processes.

In the second place, it is also clear that the combined teachings of Pacheco and all of the secondary references do not suggest applicants' selection of a halide-free carbonation catalyst, either with or without a separate transesterification catalyst, which is to be used in both steps of applicants' claimed process. The McClellan and Emmons secondary references, for example, fail to teach applicants' essential transesterification step at all, let alone what type of catalyst might be useful therein. And, in fact the primary Pacheco reference and the Emmons secondary reference teach directly away from applicants' selection of halide-free carbonation catalysts by clearly indicating that the preferred carbonation catalysts for the reference processes are halides. The Pacheco patent, for example, teaches expressly that quaternary ammonium halides are "particularly preferred." And the preferred Emmons carbonation catalyst is hydrazine hydrohalide.

With respect to the newly applied Masahiro, Haruyuki and Tojo secondary references, there is not only no suggestion of the use of any type of carbonation catalyst for cyclic carbonate production, the transesterification processes disclosed in these references clearly permit the inclusion of halide-containing catalysts. Example 1 of Tojo, for instance, which is cited by the Examiner as being especially relevant to applicants' process, utilizes a chloride-containing Dowex anion exchange resin as a catalyst. Thus the very example cited by the Examiner, like others of the secondary references, actually teaches away from the element of applicants' claimed process which requires the realization of a final product stream that has a halide concentration of 5 ppm or less.

In short, the skilled artisan reading Pacheco, McClellan, Emmons, Masahiro, Haruyuki and Tojo together would not be lead to the obvious realization of applicants' claimed process with its utilization in two process steps of the same carbonation catalyst and with its selection of catalysts and procedures which do not introduce significant amounts of corrosive halide material into the final product stream. Given this situation, it is submitted that neither Pacheco, any of the secondary references, nor their combination, teach or

suggest all of the essential features of applicants' dialkyl carbonate preparation process as presently set forth in Claims 1, 2, 4-15, 17-26, 28-39, 41-46 and 50-57. Continued application of the Pacheco-plus-secondary-references Section 103 art rejection against these claims would accordingly be improper.

CONCLUSION

Applicants have made an earnest effort to place their application in proper form and to distinguish their claimed invention from the applied prior art. WHEREFORE, reconsideration of this application, entry of the application amendment presented, withdrawal of the claim rejections under 35 U.S.C. §112 and 35 U.S.C. §103, and allowance of Claims 1, 2, 4-15, 17-26, 28-39, 41-46, and 49-57, are all respectfully requested.

If there are any questions regarding this response or the application in general, a telephone call to the undersigned would be appreciated, since this should expedite the prosecution of the application for all concerned.

Respectfully submitted,

Date: April 7, 2008 /Xiaobing Feng/

Xiaobing Feng
Attorney for Applicants
Registration No. 57,231

Post Office Address (to which correspondence is to be sent):
ExxonMobil Chemical Company
Law Technology
P.O. Box 2149
Baytown, Texas 77522-2149
Telephone No. (281) 834-0355
Facsimile No. (281) 834-2495

XF:pwr/ga/clm